A MAGNETIC FILTER DEVICE

- Description -

The present invention relates to a magnetic filter device for filtering ferromagnetic material from a fluid in which said material is suspended.

Fluid such as engine oil which circulates in an engine and/or gearbox, and hydraulic fluid which circulates in hydraulic systems, tends to accumulate ferrous material from metallic surfaces which are lubricated by the fluid. Such particulate material in suspension is liable to accelerate wear of these surfaces and thereby generate even more ferrous matter.

Conventional filters fail to filter out a substantial amount of ferrous material from the fluid, which material, is liable to cause damage to an engine and/or gearbox or hydraulic system. In addition, as there is no indication of the quantity of ferrous material in the fluid, the fluid conventionally, is changed after the engine or hydraulic system has been run for a certain period of time, in order to limit possible damage.

Previous attempts at magnetic filtration include the device of US 2 149 764 (FREI). This device has a series of cylindrical magnets separated by a series of baffle plates, which are magnetised through contact with the magnets. A cylindrical mesh encloses this arrangement, and is in turn magnetised through contact with the baffle plates. The mesh increases the magnetised area and is constrained to be part of the flow path. However, fluid flow will be disadvantageously impeded by the eventual build up of metal particles on the mesh. This arrangement furthermore generates different magnetic flux fields to the device of the present invention.

Another device FR 114 135 (PHILIPS) uses non-corrosive plates disposed either side of a cylindrical magnet. The plates are of a thickness and overall design in order to maximise the magnetisable surface area, the gaps in the plates acting as passageways. Metal is said to collect radially between the fingers of the plates.

GB 684 052 (SPODIG) shows different arrangements of magnets and plates. One such arrangement is an intermediate plate sandwiched between like poles of two magnets, with further outer plates attached to the outer faces of the magnets. It is designed so that no lines of force originate from the outer surfaces of the plates, and also so that magnetic fields are focused around the intermediate plate. The orientation of plates and magnet in the device of the present invention, is described as having the drawback of stray fields, and a limited collection area which would bulge, the magnetic field only being effective at the outer edge of the magnetic system, with a detrimental stray effect of the air gap. For the purpose of collecting particles, the ideal way, according to SPODIG, is to sandwich as thin a plate as possible, and to increase the axial lengths of the magnets, so as to hold particles up against the curved peripheral surfaces of the magnets. It is designed so that lines of force are not generated from the outer plates, and it thereby operates on a different principle to that of the present invention.

A magnetic filter device for filtering ferromagnetic material from a fluid in which said material is suspended, has an inlet means and an outlet means which are isolated from each other within the device. A pair of annular plates are attached to either side of an annular magnet of smaller diameter, which sides are of opposing magnetic polarity to thus generate a magnetic field between the pair of plates. Each plate is recessed to form radially extending pole pieces. The plates are oriented with respect to each other so that the pole pieces and recesses are axially aligned. The magnetic flux distributions thus created, divert ferromagnetic material in the fluid towards the regions defined by opposite pairs of pole pieces.

In use, the magnetic filter device can be inserted between a containing means or engine, and a conventional filter or pump, so as to enhance the collection of ferromagnetic material from the circulating fluid.

In accordance with one aspect of the present invention, a magnetic filter device for filtering ferromagnetic material from a fluid in which said material is suspended, comprises a magnet and a pair of metal plates, said magnet having faces of opposite magnetic polarity, said plates being disposed in abutment with said faces respectively, each plate having a plurality of recesses about an outer perimeter of the plate to form radially extending magnetic pole pieces, which extend beyond an outer perimeter of the magnet faces, said plates being oriented so that the recesses and pole pieces on one plate are axially aligned with those recesses and pole pieces on the other plate, wherein axially opposite recesses define passage means for said fluid and also regions from which ferromagnetic material is repelled, and wherein said pole pieces define regions to which ferromagnetic material is attracted and retained.

Preferably, the magnetic filter device is further provided with a distribution plate having a plurality of apertures which are axially alignable with said recesses, said apertures being the only passage means of fluid to said metal plates.

It is further preferred that the distribution plate, the magnet and said metal plates are each provided with a central hole which is adapted to receive a tube through which fluid can pass, said tube providing means for isolating, within the device, fluid passage in the tube from fluid flow through the recesses.

Advantageously, each recess and an outer edge of each pole piece is further provided with one or a plurality of slots.

Preferably, the outer edges of axially facing pole pieces are curved towards one another.

It is preferred that means are provided for ensuring that said recesses and said apertures are maintained in axial alignment.

The distribution plate is advantageously made of a non-ferromagnetic material. This would discourage any collection of ferromagnetic material thereon.

The magnet is advantageously made of a material which will generate a magnetic field between the metal plates which is strong enough to attract ferromagnetic material from fluid passing therebetween.

The metal plate which is impinged first by fluid flow through the device, is advantageously thicker than the other metal plate through which fluid leaves the device.

Preferably, an outer face of the tube is provided with a recess which can receive retaining means which is able to keep the distribution plate in abutment with the axially closer of said metal plates.

Advantageously, a housing is further provided, which is adapted at one end to be received by a containing means of said fluid, said containing means having an input means and an output means, the housing being adapted at the other end to receive a filter of known type, an output of which known filter is continuous with the tube in the magnetic filter device and also the input means to the containing means, said output means from the containing means being continuous with the apertures in the distribution plate and the recesses in the metal plates.

In a further embodiment, the magnetic filter device is provided with two distribution plates disposed either side of each of the metal plates, each distribution plate having a plurality of apertures which are axially alignable with said recesses, said apertures being the only passage means of fluid to said metal plates, the apertures in both distribution plates providing inlet and outlet means for bi-directional axial flow of fluid.

In accordance with a further aspect of the present invention, there is provided a magnetic filter device for filtering ferromagnetic material from a fluid in which said material is suspended, which comprises a known filter, a magnet and a pair of metal plates, said magnet having faces of opposite magnetic polarity, said plates being disposed in abutment with said faces respectively, each plate having a plurality of recesses about an outer perimeter of the plate to form radially extending magnetic pole pieces, which extend beyond an outer perimeter of the magnet faces, said plates being oriented so that the recesses and pole pieces on one plate are axially aligned with those recesses and pole pieces on the other plate, wherein axially opposite recesses define passage means for said fluid and also regions from which ferromagnetic material is

repelled, and wherein said pole pieces define regions to which ferromagnetic material is attracted and retained, said known filter having passage means for said fluid which is continuous with fluid passage through said recesses.

A specific embodiment of the present invention will now be described with reference to the accompanying drawings, in which:

Fig. 1 is a cross-section through a magnetic filter device in accordance with one aspect of the present invention;

Fig. 2 is an exploded perspective view of the device in fig.1;

Fig. 3 is a top view of the distribution plate in figs. 1 & 2,

Fig. 4 is a top view of one of the metal plates in the device, and

Fig. 5 is a schematic diagram illustrating one application of the device in figs. 1 to 4.

A magnetic filter device 1, as shown in figs.1 & 2, for filtering ferromagnetic material (not shown) from a fluid (not shown) in which said material is suspended, comprises a magnet 2 having two faces 3, 4 of opposite magnetic polarity, against which faces 3, 4, abut metal plates 5, 6, respectively. The plates 5, 6 are provided with a plurality of recesses 7, 8 respectively, in outer circumferential edges 9, 10 of said plates 5, 6 so as to form pole pieces 11, 12 as shown in figs. 2 and 4. Equal numbers of such pole pieces, 11, 12 are formed in each plate 5, 6, and the latter oriented so that the pole pieces 11 and recesses 7 of the plate 5, are axially aligned with the respective pole pieces 12 and recesses 8 of the plate 6. Axially displaced pairs of pole pieces 11, 12 have opposite magnetic polarity by virtue of their respective locations on the faces 3, 4 of the magnet 2. They overlap an outer edge 13 of the magnet 2 to define radially extending collecting regions 14 in which ferromagnetic particles subject to the magnetic fields generated therein, can be retained. The ends of each pair of pole pieces 11, 12 are curved towards each other to further enhance the strength and distribution of the magnetic fields. Furthermore, because each recess 7, 8 is flanked radially by

portions of metal of like polarity, ferromagnetic material is repelled towards the collecting regions 14 and also away from the path of fluid flow.

Each pole piece 11, 12 and each recess 7, 8 is further provided with a slot 15. Each slot 15 defines adjacent regions of like polarity in which a strongly repelling magnetic field is thus generated. Such fields further promote the retention of ferromagnetic material to the regions 14 between facing pole pieces.

Apertures 16, 17 centrally disposed in plates 5, 6 axially align with a central aperture 18 in the magnet 2 to form a channel 19 in the device 1, in which a central tube 20 is disposed. The tube 20 extends beyond the collective thicknesses of the plates 5, 6 and the magnet 2.

A distribution plate 21, as shown in fig. 3, has a central aperture 22 which enables the distribution plate 21 to be threaded over an end 23 of the central tube 20, so as to be disposed adjacent to the metal plate 5. The plate 21 is further provided with apertures 24 equal in number to the recesses 7, 8 in each of the plates 5, 6. The distribution plate 21 is disposed about the tube 20 so that the apertures 24 are axially aligned with the recesses 7, 8 in the metal plates 5, 6. The plates 5, 6 are each provided with flats 25, 26 in the apertures 16, 17 respectively, and the aperture 22 of the distribution plate 21 is also provided with a flat 27 of similar size. In the orientation described above where the apertures 24 and the recesses 7, 8 are in axial alignment, the flats 25, 26 and 27 are also axially aligned. The tube 20 is provided with a flattened region 28 on an outer face 30 against which the flats 25, 26 and 27 of the plates 5, 6 and 21 are disposed in order to maintain the above-mentioned orientation when the magnetic filter device 1 is assembled.

The distribution plate 21 has a flange portion 29 about the central aperture 22. The outer face 30 of the central tube 20 is further provided with an annular recess 31 which is adapted to receive a circlip 32 which abuts the flange portion 29 when the distribution plate 21 is in abutment with the metal plate 5.

The distribution plate 21 may be circumferentially sealed against a housing (not shown) to ensure that only fluid which flows through apertures 24 in the distribution plate 21 passes through to the recesses 7, 8.

In one example of an application of the magnetic filter device 1, the latter is removeably disposed between a known containing means 33 for fluid 34 to be filtered in a system in use (not shown), and a known filter unit 35, as shown in fig. 5.

The known filter unit 35 is attachable to the containing means 33 by means of a bolt 36 which enters a lower face of the filter unit 35, passes through its centre, continues out through an upper portion of the unit 35 and screws into a part of the containing means 33. A spring 37 provided between a block of filter material 38 and a base of the filter unit 35 is further compressed to accommodate the insertion of the magnetic filter device 1 between the containing means 33 and the filter unit 35.

The distribution plate 21 is sealed against the filter unit 35 by annular sealing means 39. The central tube 20 is sealed against the containing means 33 and a surface 40 of the known filter unit 35 by sealing means 41 and 42 respectively.

Fluid 34 exits the containing means 33 through an outlet port 43. It flows towards the distribution plate 21 and thus through axially coincident apertures 24 and recesses 7, 8 in the distribution plate 21 and the plates 5, 6 respectively. From the magnetic filter device 1, fluid enters the known filter unit 35 and flows to the filter material 38, in which other particles in suspension can be retained. Fluid exits the filter material 38 and flows through a central passage 44 which is continuous with the central tube 20 of the magnetic filter device 1. From the central tube 20 of the device 1, fluid re-enters the containing means 33 through an input port 45. It is then recirculated around the system in use before its return to the outlet port 43. More ferromagnetic material is retained with the increased frequency of circulation of fluid through the magnetic filter device 1.

In the event of blockage of the filter material 38, a pressure relief valve 46 allows fluid to bypass the filter material 38 and proceed through to the central passage 44. Material retained in the filter material 38 up to this point may then be

disadvantageously washed back into the circulation. However, since fluid input into the magnetic filter device 1 is isolated from fluid output, any particles collected in the magnetic filter device 1 will be retained in such an event.

In such an arrangement, the magnetic filter device 1, can act as a convenient check point for the amount of wear on engine and/or gearbox components or hydraulic system, and therefore enhance their safety and efficiency.

In a further embodiment, the magnetic filter device can be oriented with respect to a known filter unit so as to have the distribution plate 21 facing the direction of fluid flow.

In a further embodiment, the filter device can be an integral member of a known filter unit.